

## § 1065.360

## 40 CFR Ch. I (7–1–13 Edition)

### HYDROCARBON MEASUREMENTS

#### § 1065.360 FID optimization and verification.

(6) Allow time for the analyzer response to stabilize. Stabilization time may include time to purge the transfer line and to account for analyzer response.

(7) While the analyzer measures the sample's concentration, record its output for 30 seconds. Calculate the arithmetic mean of this data.

(8) The analyzer meets the interference verification if the result of paragraph (d)(7) of this section meets the tolerance in paragraph (c) of this section.

(9) You may also run interference procedures for CO<sub>2</sub> and H<sub>2</sub>O separately. If the CO<sub>2</sub> and H<sub>2</sub>O levels used are higher than the maximum levels expected during testing, you may scale down each observed interference value by multiplying the observed interference by the ratio of the maximum expected concentration value to the actual value used during this procedure. You may run separate interference concentrations of H<sub>2</sub>O (down to 0.025 mol/mol H<sub>2</sub>O content) that are lower than the maximum levels expected during testing, but you must scale up the observed H<sub>2</sub>O interference by multiplying the observed interference by the ratio of the maximum expected H<sub>2</sub>O concentration value to the actual value used during this procedure. The sum of the two scaled interference values must meet the tolerance in paragraph (c) of this section.

(e) *Exceptions.* The following exceptions apply:

(1) You may omit this verification if you can show by engineering analysis that for your CO sampling system and your emission-calculation procedures, the combined CO<sub>2</sub> and H<sub>2</sub>O interference for your CO NDIR analyzer always affects your brake-specific CO emission results within  $\pm 0.5\%$  of the applicable CO standard.

(2) You may use a CO NDIR analyzer that you determine does not meet this verification, as long as you try to correct the problem and the measurement deficiency does not adversely affect your ability to show that engines comply with all applicable emission standards.

[70 FR 40516, July 13, 2005, as amended at 73 FR 37308, June 30, 2008; 73 FR 59328, Oct. 8, 2008; 75 FR 23041, Apr. 30, 2010]

(a) *Scope and frequency.* For all FID analyzers, calibrate the FID upon initial installation. Repeat the calibration as needed using good engineering judgment. For a FID that measures THC, perform the following steps:

(1) Optimize the response to various hydrocarbons after initial analyzer installation and after major maintenance as described in paragraph (c) of this section.

(2) Determine the methane (CH<sub>4</sub>) response factor after initial analyzer installation and after major maintenance as described in paragraph (d) of this section.

(3) Verify the methane (CH<sub>4</sub>) response within 185 days before testing as described in paragraph (e) of this section.

(b) *Calibration.* Use good engineering judgment to develop a calibration procedure, such as one based on the FID-analyzer manufacturer's instructions and recommended frequency for calibrating the FID. Alternately, you may remove system components for off-site calibration. For a FID that measures THC, calibrate using C<sub>3</sub>H<sub>8</sub> calibration gases that meet the specifications of § 1065.750. For a FID that measures CH<sub>4</sub>, calibrate using CH<sub>4</sub> calibration gases that meet the specifications of § 1065.750. We recommend FID analyzer zero and span gases that contain approximately the flow-weighted mean concentration of O<sub>2</sub> expected during testing. If you use a FID to measure methane (CH<sub>4</sub>) downstream of a non-methane cutter, you may calibrate that FID using CH<sub>4</sub> calibration gases with the cutter. Regardless of the calibration gas composition, calibrate on a carbon number basis of one (C<sub>1</sub>). For example, if you use a C<sub>3</sub>H<sub>8</sub> span gas of concentration 200  $\mu\text{mol/mol}$ , span the FID to respond with a value of 600  $\mu\text{mol/mol}$ . As another example, if you use a CH<sub>4</sub> span gas with a concentration of 200  $\mu\text{mol/mol}$ , span the FID to respond with a value of 200  $\mu\text{mol/mol}$ .

(c) *THC FID response optimization.* This procedure is only for FID analyzers that measure THC. Use good engineering judgment for initial instrument start-up and basic operating adjustment using FID fuel and zero air. Heated FIDs must be within their required operating temperature ranges. Optimize FID response at the most common analyzer range expected during emission testing. Optimization involves adjusting flows and pressures of FID fuel, burner air, and sample to minimize response variations to various hydrocarbon species in the exhaust. Use good engineering judgment to trade off peak FID response to propane calibration gases to achieve minimal response variations to different hydrocarbon species. For an example of trading off response to propane for relative responses to other hydrocarbon species, see SAE 770141 (incorporated by reference in § 1065.1010). Determine the optimum flow rates and/or pressures for FID fuel, burner air, and sample and record them for future reference.

(d) *THC FID CH<sub>4</sub> response factor determination.* This procedure is only for FID analyzers that measure THC. Since FID analyzers generally have a different response to CH<sub>4</sub> versus C<sub>3</sub>H<sub>8</sub>, determine each THC FID analyzer's CH<sub>4</sub> response factor,  $RF_{CH_4[THC-FID]}$ , after FID optimization. Use the most recent  $RF_{CH_4[THC-FID]}$  measured according to this section in the calculations for HC determination described in § 1065.660 to compensate for CH<sub>4</sub> response. Determine  $RF_{CH_4[THC-FID]}$  as follows, noting that you do not determine  $RF_{CH_4[THC-FID]}$  for FIDs that are calibrated and spanned using CH<sub>4</sub> with a nonmethane cutter:

(1) Select a C<sub>3</sub>H<sub>8</sub> span gas concentration that you use to span your analyzers before emission testing. Use only span gases that meet the specifications of § 1065.750. Record the C<sub>3</sub>H<sub>8</sub> concentration of the gas.

(2) Select a CH<sub>4</sub> span gas concentration that you use to span your analyzers before emission testing. Use only span gases that meet the specifications of § 1065.750. Record the CH<sub>4</sub> concentration of the gas.

(3) Start and operate the FID analyzer according to the manufacturer's instructions.

(4) Confirm that the FID analyzer has been calibrated using C<sub>3</sub>H<sub>8</sub>. Calibrate on a carbon number basis of one (C<sub>1</sub>). For example, if you use a C<sub>3</sub>H<sub>8</sub> span gas of concentration 200 µmol/mol, span the FID to respond with a value of 600 µmol/mol.

(5) Zero the FID with a zero gas that you use for emission testing.

(6) Span the FID with the C<sub>3</sub>H<sub>8</sub> span gas that you selected under paragraph (d)(1) of this section.

(7) Introduce at the sample port of the FID analyzer, the CH<sub>4</sub> span gas that you selected under paragraph (d)(2) of this section.

(8) Allow time for the analyzer response to stabilize. Stabilization time may include time to purge the analyzer and to account for its response.

(9) While the analyzer measures the CH<sub>4</sub> concentration, record 30 seconds of sampled data. Calculate the arithmetic mean of these values.

(10) Divide the mean measured concentration by the recorded span concentration of the CH<sub>4</sub> calibration gas. The result is the FID analyzer's response factor for CH<sub>4</sub>,  $RF_{CH_4[THC-FID]}$ .

(e) *THC FID methane (CH<sub>4</sub>) response verification.* This procedure is only for FID analyzers that measure THC. If the value of  $RF_{CH_4[THC-FID]}$  from paragraph (d) of this section is within ±5% of its most recent previously determined value, the THC FID passes the methane response verification. For example, if the most recent previous value for  $RF_{CH_4[THC-FID]}$  was 1.05 and it changed by ±0.05 to become 1.10 or it changed by -0.05 to become 1.00, either case would be acceptable because ±4.8% is less than ±5%. Verify  $RF_{CH_4[THC-FID]}$  as follows:

(1) First verify that the flow rates and/or pressures of FID fuel, burner air, and sample are each within ±0.5% of their most recent previously recorded values, as described in paragraph (c) of this section. You may adjust these flow rates as necessary. Then determine the  $RF_{CH_4[THC-FID]}$  as described in paragraph (d) of this section and verify that it is within the tolerance specified in this paragraph (e).

(2) If  $RF_{CH_4[THC-FID]}$  is not within the tolerance specified in this paragraph (e), re-optimize the FID response as described in paragraph (c) of this section.

(3) Determine a new  $RF_{CH_4[THC-FID]}$  as described in paragraph (d) of this section. Use this new value of  $RF_{CH_4[THC-FID]}$  in the calculations for HC determination, as described in § 1065.660.

[73 FR 37308, June 30, 2008, as amended at 75 FR 23041, Apr. 30, 2010; 76 FR 57447, Sept. 15, 2011]

**§ 1065.362 Non-stoichiometric raw exhaust FID O<sub>2</sub> interference verification.**

(a) *Scope and frequency.* If you use FID analyzers for raw exhaust measurements from engines that operate in a non-stoichiometric mode of combustion (e.g., compression-ignition, lean-burn), verify the amount of FID O<sub>2</sub> interference upon initial installation and after major maintenance.

(b) *Measurement principles.* Changes in O<sub>2</sub> concentration in raw exhaust can affect FID response by changing FID flame temperature. Optimize FID fuel, burner air, and sample flow to meet this verification. Verify FID performance with the compensation algorithms for FID O<sub>2</sub> interference that you have active during an emission test.

(c) *System requirements.* Any FID analyzer used during testing must meet the FID O<sub>2</sub> interference verification according to the procedure in this section.

(d) *Procedure.* Determine FID O<sub>2</sub> interference as follows, noting that you may use one or more gas dividers to create the reference gas concentrations that are required to perform this verification:

(1) Select three span reference gases that contain a C<sub>3</sub>H<sub>8</sub> concentration that you use to span your analyzers before emission testing. Use only span gases that meet the specifications of § 1065.750. You may use CH<sub>4</sub> span reference gases for FIDs calibrated on CH<sub>4</sub> with a nonmethane cutter. Select the three balance gas concentrations such that the concentrations of O<sub>2</sub> and N<sub>2</sub> represent the minimum, maximum, and average O<sub>2</sub> concentrations expected during testing. The requirement for using the average O<sub>2</sub> concentration can

be removed if you choose to calibrate the FID with span gas balanced with the average expected oxygen concentration.

(2) Confirm that the FID analyzer meets all the specifications of § 1065.360.

(3) Start and operate the FID analyzer as you would before an emission test. Regardless of the FID burner's air source during testing, use zero air as the FID burner's air source for this verification.

(4) Zero the FID analyzer using the zero gas used during emission testing.

(5) Span the FID analyzer using a span gas that you use during emission testing.

(6) Check the zero response of the FID analyzer using the zero gas used during emission testing. If the mean zero response of 30 seconds of sampled data is within  $\pm 0.5\%$  of the span reference value used in paragraph (d)(5) of this section, then proceed to the next step; otherwise restart the procedure at paragraph (d)(4) of this section.

(7) Check the analyzer response using the span gas that has the minimum concentration of O<sub>2</sub> expected during testing. Record the mean response of 30 seconds of stabilized sample data as  $x_{O_2minHC}$ .

(8) Check the zero response of the FID analyzer using the zero gas used during emission testing. If the mean zero response of 30 seconds of stabilized sample data is within  $\pm 0.5\%$  of the span reference value used in paragraph (d)(5) of this section, then proceed to the next step; otherwise restart the procedure at paragraph (d)(4) of this section.

(9) Check the analyzer response using the span gas that has the average concentration of O<sub>2</sub> expected during testing. Record the mean response of 30 seconds of stabilized sample data as  $x_{O_2avgHC}$ .

(10) Check the zero response of the FID analyzer using the zero gas used during emission testing. If the mean zero response of 30 seconds of stabilized sample data is within  $\pm 0.5\%$  of the span reference value used in paragraph (d)(5) of this section, proceed to the next step; otherwise restart the procedure at paragraph (d)(4) of this section.

(11) Check the analyzer response using the span gas that has the maximum concentration of O<sub>2</sub> expected